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Benthological studies during cruise MSM02/3 of RV Maria S. Merian

From July 31 to August 17, 2006, we participated in cruise MSM02/3 of R/V „Maria S. Merian" (Fig. 1). The overall scientific objective of this expedition was to analyse environmental controls and postglacial climate variability of biosedimentary systems at selected study areas on the shelves around Svalbard (Fig. 2). The major working tool was the manned submersible JAGO (Fig. 3), which operated in topographically complex submarine terrains that are difficult to sample with conventional gear.

Fig. 1 *RV Maria S. Merian during cruise MSM02/3*

Within the integrated multidisciplinary approach of the cruise, involving oceanographic, geological and biological studies, the main objective of our benthological sampling programme was to analyse spatial variations in the structure of benthic assemblages in the study area. In the investigated coastal habitats, the distribution, composition and abundance of the benthos are assumed to be mainly controlled by light penetration (and, hence, the occurrence of coralline red algae) and the kinetic energy regime (waves, current, tides). As these factors depend very much on the water depth, a depth zonation is likely to be the most pronounced pattern in the distribution of benthic assemblages. In addition, sedimentation setting (which in turn is largely determined by the presence or absence of glaciers) is of special significance off Svalbard coasts.

Within the greater context of international and multidisciplinary cooperation, the analyses will contribute to the documentation of the present condition of the marine ecosystems off Svalbard. This is an important issue, as most ecological models agree in the prediction that northern seas will experience particularly severe ecosystem shifts because of pronounced sea temperature rise and rapid seaice reduction. Due to the influence of the North Atlantic Current system, even now most benthic species inhabiting the coastal waters off Svalbard,

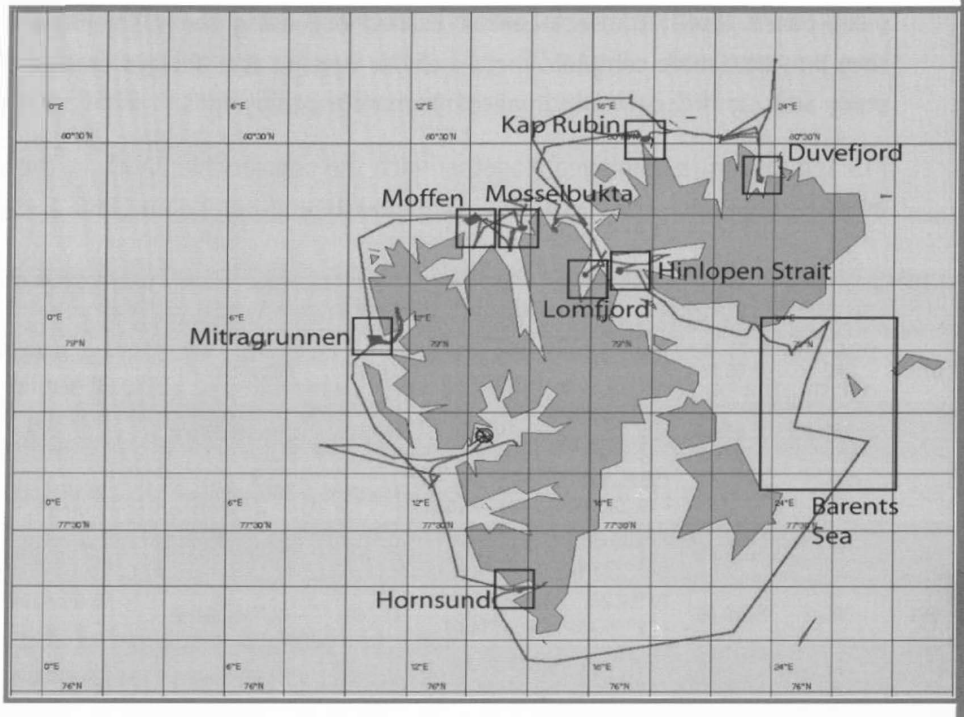

Fig 2 *Route and study areas of RV Maria S. Merian during cruise MSM02/3*

particularly at the western and northern coasts, are actually of Atlantic origin, i.e., they are immigrants from the south that occur at both polar and boreal latitudes. Endemic Arctic species, which are adapted to extremely low temperatures characterizing polar environments and do occur in Arctic waters only, are clearly less numerous than those Arctic-boreal species. Due to the expected climate-related ecosystem shifts, their numbers are likely to further decrease, especially in transition regions between sub-Arctic and high-Arctic climates, such as Svalbard. We will test whether this trend has already set off.

Fig 3 *Manned submersible JAGO, being deployed in the Lamfjord (Spitsbergen)vv*

Sampling

The composition, abundance and distribution of seafloor communities of the Svalbard shelf were investigated – in addition to JAGO – by means of three gears: (1) dredge (DRG; Fig. 4), (2) van Veen grab (BG; Fig. 5), and (3) photographic probe (FTS; Fig. 6). The basic idea behind the use of a combination of different gears was that each method has its specific pros and cons and is most adequate for the sampling of different community fractions and at different seafloor types. Together, especially if their results are combined with those gained with the

video-based ‚visual transect census' carried out using the submersible JAGO, they provide a more complete picture of the benthic assemblages present in the study area, as if they would in case of separate deployment.

FTS and DRG were employed, together with the submersible JAGO, in the study areas Mitragrunnen, Moffen Island, Mosselbukta and Kap Rubin (Tab. 1, Fig. 7).

Tab 1 *Benthic sampling stations during R/V MARIA S. MERIAN Cruise 02/3: BG – van Veen grab; DRG – Dredge; FTS – Photographic probe*

MSM 02/3 No.	Gear	Date	Latitude N	Longitude E	Depth (m)	Region	Remarks
636	DRG-1	02.08.06	79°05,47' - 79°05,68'	10°48,17' -10°49,38'	98- 99	Mitragrunnen	Course 129°; 15min; 1kn
637	DRG-2	02.08.06	79°05,91' - 79°05,84'	10°47,69' -10°46,37'	48- 49	Mitragrunnen	Course 262°; 15min; 1kn
653	FTS-1	04.08.06	79°05,940' - 79°05,701'	10°45,63' - 10°46,84'	41- 69	Mitragrunnen	25 pictures
660	FTS-2	05.08.06	79°59,534' - 79°59,469'	14°13,962' - 14°13,335'	39- 48	Moffen Island	20 pictures
661	DRG-3	05.08.06	79°59,26' - 79°59,45'	14°15,28' -14°14,08'	40- 40	Moffen Island	Course 309°; 15min; 1kn
674	FTS-3	06.08.06	79°54,591' - 79°54,647'	15°48,906' - 15°48,069'	40- 51	Mosselbukta	30 pictures
675	DRG-4	06.08.06	79°54,21' - 79°53,53'	15°46,94' -15°44,89'	61- 72	Mosselbukta	Course 206°; 15min; 1kn
696	BG-1	08.08.06	79°58,02' - 79°58,02'	17°44,54' -17°44,55'	383	Northern Hinlopen Strait	Three proper replicates
704	DRG-5	09.08.06	80°31,22' - 80°31,44'	19°44,23' -19°43,02'	45- 43	Kap Rubin	Course 26°; 15min; 1kn
705	FTS-4	09.08.06	80°32,039' - 80°31,988'	19°50,745' - 19°51,383'	88- 24	Kap Rubin	29 pictures
720	BG-2	11.08.06	80°18,94' - 80°18,73'	23°25,18' -23°25,67'	312- 321	Duvefjord	Three proper replicates
722	FTS-5	11.08.06	80°15,312' - 80°15,502'	23°33,435' - 23°33,919'	47- 42	Duvefjord	30 pictures
734	DRG-6	13.08.06	79°34,96' - 79°34,69'	17°50,78' -17°50,94	43-49	Lomfjord	Course 171°; 15min; 1kn
735	FTS-6	13.08.06	79°34,800' - 79°34,789'	17°50,504' - 17°51,664'	54- 66	Lomfjord	30 pictures
737	BG-3	13.08.06	79°41,01' - 79°41,01'	18°18,07' -18°18,07'	417- 417	Lomfjord	Three proper replicates
743	FTS-7	14.08.06	79°35,838' - 79°36,005'	18°52,195' -18°51,820'	25- 239	Hinlopen Strait	30 pictures
744	BG-4	14.08.06	79°14,16' - 79°14,16'	20°53,38' -20°53,38'	79- 79	Southern Hinlopen Strait	Three proper replicates
746	BG-5	14.08.06	78°59,20' - 78°59,20'	24°35,83' -24°35,83'	208	Barents Sea	Three proper replicates
747	BG-6	15.08.06	79°13,10' - 79°13,10'	25°51,27' -25°51,28'	192	Barents Sea	Three proper replicates
748	BG-7	15.08.06	78°46,03' - 78°46,03'	25°08,28' -25°08,28'	122	Barents Sea	Three proper replicates
749	BG-8	15.08.06	78°23,14 - 78°23,14	24°44,45 -24°44,45	138	Barents Sea	Three proper replicates
750	BG-9	15.08.06	78°16,19' - 78°16,19'	27°11,70 -27°11,70	312	Barents Sea	Three proper replicates
755	FTS-8	16.08.06	79°57,181' - 79°57,183'	15°45,014' - 15°44,320'	40- 95	Hornsund	30 pictures

In the Duvefjord, we combined the FTS and BG. In the Lomfjord, it was possible to combine all four techniques JAGO, DRG, FTS and BG. The Hornsund was sampled by JAGO and FTS. The stations in the northwestern Barents Sea were sampled by BG only.

Dredge

The dredge was used to collect macro- and megabenthic epifauna. This gear does not provide quantitative samples but it can be employed on grounds made up by pebbles, cobbles and stones, i.e., at locations where the use of grabs and corers is not possible because these gears do not close and thus do not provide samples at all.

The dredge used during the cruise consists of a rectangular frame (100 cm wide and 40 cm high), to which a net of 150 cm length and 0.5 cm mesh size is fixed (Fig. 4).

The main objective of the dredge hauls was a qualitative species inventory of the benthic fauna and flora. In addition, the results will help to identify the organisms visible in the video footage obtained during JAGO dives and in the seabed pictures provided by the photographic probe.

Fig 4 *Dredge used during cruise MSM02/3 of RV Maria S. Merian*

During the cruise the dredge was employed at a total of 6 stations (Tab. 1, Fig. 7), all of which were in close proximity to the locations of JAGO dives and/or deployments of the photographic probe. All live specimens were sorted out of the catches and identified to lowest possible taxonomic level (putative species). Moreover, for each taxon identified the gross abundance was estimated (using a logarithmic abundance classification scheme), and voucher specimens were selected and fixed in a 4% formalin-seawater solution for later more precise identification in the lab.

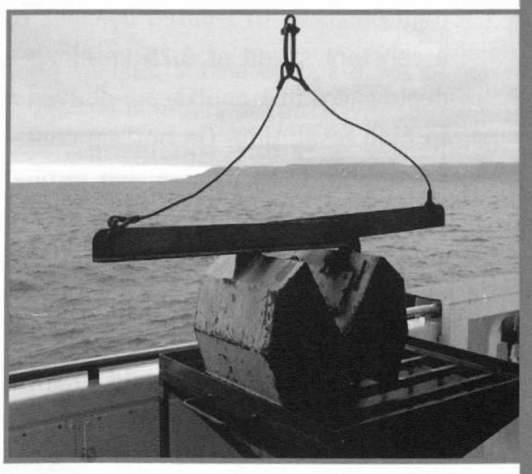

Fig 5 *Van-Veen grab used during cruise MSM02/3 of RV Maria S. Merian*

Van Veen-type grab

A van Veen grab was employed to obtain quantitative samples of the macrobenthos. The grab used during the cruise measured 60 cm in width and 30 cm in height. It had an opening of 46.5 x 46.5 cm (Fig. 5). It was deployed at a total of 9 stations (Tab. 1, Fig. 7). Their posi-

tions were selected according to three criteria: (1) the seabed texture has to be appropriate (in case the seafloor primarily consists of sand, pebbles and stones the grab will not close (see above); (2) stations sampled last year by Norwegian colleagues are revisited; and (3) getting samples from areas that have not been investigated to date. For statistical reasons, at each station three replicate samples were taken in order to investigate the smallscale patchiness of the benthic fauna. Samples were gently washed through a sieve of 1 mm mesh size, and the sieve residue was fixed in 70% alcohol for later analysis of species composition, abundance and biomass in the lab after the cruise.

Photographic probe

The photographic probe was used to obtain high resolution stills of the seabed, complementing the video footage obtained during the JAGO dives. The primary goal of its use was a quantitative inventory of the megabenthic epifauna.

The probe basically consisted of a vertically oriented still camera (PHOTOSEA™

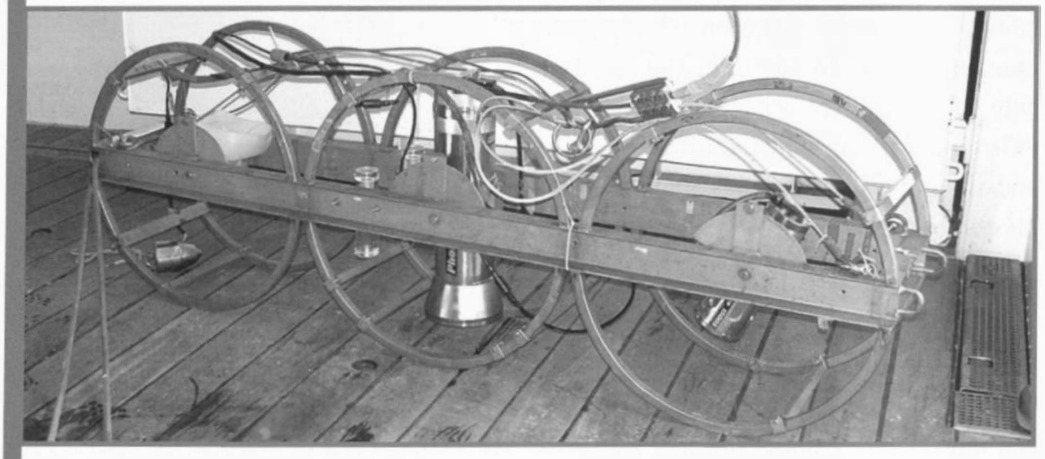

Fig 6 *Photographic probe used during cruise MSM02/3 of RV Maria S. Merian*

70 D) and an obliquely oriented strobe (PHOTOSEA™ 1500 D), both aligned 1 m apart from each other in a steel frame of 2.3 m length in total (Fig. 6). It was vertically lowered to the sea floor from the ship, which by means of its high-precision GPS-based Dynamic Positioning System (DPS) moved slowly with a constant speed of 0.25 kn along a transect that was determined before the deployment in a multibeam-derived map displaying the bathymetry of the study in high resolution. On bottom contact of a weight hanging about 1.4 m below the probe, both camera and strobe were triggered, and bottom contact was signalled to the ship via a single conductor cable. The gear was then heaved a few metres and subsequently lowered again for the next bottom contact and seabed exposure. By control of the ship's DPS, the interval between the single shots was kept constant at approximately 10 m. In this manner, series of 30 nonoverlapping photographs, distributed along the predefined 300m transects, were obtained at each station [at some stations, less than 30 shots were taken due to technical problems]. The system did not comprise a video camera allowing for realtime monitoring; i.e. all sea floor photographs were taken blindly. As

the distance be¬tween camera and seabed was kept constant for each exposure by means of the trigger mechanism, the bottom area imaged by each photograph was the same (1 m2). Two laser light points with a distance of 22.5 cm to each other were projected on the depicted seabed area and provided a scale in each photo.

In total, 224 seabed photographs were taken at 8 stations at water depths ranging from 25 to 240 m (Tab. 1, Fig. 7). The station plan was designed in order to complement the video surveys carried out by JAGO, i.e., whenever feasible, the photographic transects were embedded into the video transects covered by JAGO.

The exposed slides will be developed and analysed at home. The high resolution of the sea floor pictures, due to the relatively small camera-seabed distance and the high quality of the optical system and film material used (KODAK EKTACHROME™ 64 ASA 70 mm colour slide film), will allow to investigate epibenthic individuals as small as 1 mm. The „closeup" pictures of the sea floor (for an example, see Fig. 8) will be evaluated according to the following aspects:

(a) „in situ" observations of epibenthic habitat structures
(b) quantitative determination of absolute population densities
(c) identification of spatial distribution patterns and, if population densities are sufficiently high,
(d) assessment of size spectra of large epibenthic organisms

For species identification, megabenthic specimens were collected from dredge catches taken at the same or nearby locations. In the course of the quantitative analysis of the photographs, epibenthic organisms will be determined by comparison with these specimens (and, if necessary, with the help of taxonomic experts) and counted. For comparative analyses, these counts will be raised to absolute abundance values (ind m^{-2}).

Preliminary results

Dredge catches

Overall, the number of macrobenthic (putative) species, sorted on board out of the dredge catches (Fig. 4), totals 111 (Tab. 2). The numbers of (putative) species per station ranged from 18 at station 636 (Mitragrunnen) to 46 at station 675 (Mosselbukta) (Tab. 2). Overall, Crustacea were most diverse (24; Tab. 3),

Station	636	637	661	675	704	734
Total: 111	18	34	35	46	41	45

Tab 2 *Number of putative species (live specimens only) in dredge samples.*

followed by Mollusca (23), Polychaeta (15), and Echinodermata (14). Only two species – the brittle star Ophiopholis aculeata (Echinodermata: Ophiuroidea) and the prawn Lebbeus polaris (Crustacea: Decapoda) – were present in all catches.

Tab 3 *Number of (putative) species for higher taxa in dredge catches.*

Taxonomic group	Number of (putative) species
Rhodophyta	2
Phaeophyta	1
Porifera	2
Cnidaria	8
Brachiopoda	1
Bryozoa	4
Sipunculida	2
Nemertea	1
Mollusca	23
Polyplacophora	1
Gastropoda	15
Bivalvia	7
Polychaeta	15
Pantopoda	4
Crustacea	24
Echinodermata	14
Crinoidea	1
Asteroidea	4
Ophiuroidea	6
Echinoidea	2
Holothuroidea	1
Chordata	10
Ascidiacea	2
Pisces	8

Note that these numbers are conservative estimates of species richness, as it is certain that more species will be added in a more detailed analysis in the lab after the cruise.

JAGO video footage

In a preliminary analysis undertaken on board, part of the video footage gained during JAGO dives (10 stations in total) was scanned for the composition of the epibenthic assemblages imaged along the dive transects.

In total, the number of megabenthic (putative) species, identified in the video footage, was 57 (Tab. 4). The numbers per station ranged from 2 at station 647 to 29 at station 684 (Tab. 4). Echinoderms were most diverse (13; Tab. 5), followed by Cnidaria (9), Mollusca (8), and Chordata (7).

Tab 4 *Number of putative species identified in video footage gained during 10 JAGO dives.*

Station	634	644	647	652	657	671	680	684	711	731
Total: 57	14	14	2	12	16	18	8	20	29	13

It should again be noted that these numbers are conservative estimates of species richness, as it is certain that more species will be added in a more detailed, visual transect census' carried out in the lab after the cruise.